Alaska Department of Fish and Game
Division of Wildlife Conservation
November 2001

Northern Goshawk Monitoring, Population Ecology and Diet on the Tongass National Forest

1 April 1991–30 September 2001

Craig Flatten
Kimberly Titus
Richard Lowell

Final Research Performance Report
Endangered Species Conservation Fund
Federal Aid Grant SE-4, studies 2 to 6

If using information from this report, please credit the author(s) and the Alaska Department of Fish and Game. The reference may include the following: Flatten, C., K. Titus and R. Lowell. 2001. Northern Goshawk monitoring, population ecology and diet on the Tongass National Forest, April 1991–Sept 2001. Alaska Dept. of Fish and Game. Final research report. Endangered species conservation fund federal aid grant SE-4, studies 2 to 6. Juneau, Alaska. 32 pp.

RESEARCH FINAL PERFORMANCE REPORT

STATE: Alaska **STUDY:** SE-4-2-6

COOPERATOR: USDA Forest Service, US Fish & Wildlife Service

GRANT: SE-4

TITLE: Northern Goshawk monitoring, population ecology and diet on the Tongass National Forest

AUTHORS: Craig Flatten, Kimberly Titus, and Richard Lowell

PERIOD: 1 April 1991–30 September 2001

Editor's Note: Although the grant for this project began in 1995, in this final research report authors discuss nesting data as far back as 1991 during the program's onset when the USDA Forest Service and Alaska Department of Fish and Game funded this project. The title for Grant SE-4-2-6 includes additional focus on diet brought to this project through contract amendment.

SUMMARY

There is a need to evaluate the status, population, and habitat ecology of the northern goshawk (*Accipiter gentilis*) on the Tongass National Forest (Tongass). The northern goshawk was a key design species in the revision of the Tongass Land and Resource Management Plan (TLMP; US Forest Service 1997), and the US Fish and Wildlife Service reviewed this species for possible listing under the Endangered Species Act. TLMP has a number of requirements for monitoring goshawks on the Tongass and for maintaining goshawk habitat across the landscape. During 1991–1999, the Alaska Department of Fish and Game (ADF&G) and the US Forest Service (USFS) located and monitored goshawk nesting areas across the Tongass as part of an interagency study of the ecology and habitat relationships of this species in Southeast Alaska. Sixty-one nesting areas were documented within a study area approximately 77,000 km^2 (30,000 mi^2). Nesting areas were initially located during activities associated with timber sales (61%), recreation (10%), agency bird surveys (8%), or by tracking radiotagged adult goshawks (21%). Most nesting areas were located in remote areas and the majority (68%) used floatplanes for principal access; more than half (58%) required more than one type of motorized transportation for access. Nesting areas were searched annually 1 to >10 times during attempts to determine occupancy, nesting status, and productivity. Searches were aided by radiotelemetry or by standard goshawk detection methods, including broadcasting conspecific calls, watching for goshawks in flight above the forest canopy, listening for goshawk vocalizations, and accessing nest sites and surrounding areas by foot to search for clues of goshawks and nesting. We did not test the efficacy of these detection methods or apply them under strict protocol. Annual searches of nesting areas were conducted during a total of 283 nesting

area-years at 59 nesting areas. Across all years 1991–99, a mean of 83% (annual range = 71–96%) of known nesting areas were searched each year; a mean of 14% (annual range = 0–29%) of known nesting areas were searched each year by tracking radiotagged adults, and a mean of 70% (annual range = 53–80%) of known nesting areas were searched each year without the aid of radiotelemetry. Despite extensive efforts each breeding season to detect goshawks and nesting activity, our results from 9 years of nesting area monitoring indicate that nesting area searches done without the aid of radiotelemetry had limited success. This observation is supported by our general field experience and analysis of data from radiotagged goshawks concerning nesting area fidelity and annual movement between nests, both within and between nesting areas (see below). Various factors are believed to have affected the negative outcome of many nesting area searches done without radiotelemetry. These principally include 1) the dense rainforests and 2) frequently inclement weather of our study area, which hindered our ability to access nesting areas and detect goshawks, 3) the potentially large size of nesting areas (see below), and 4) the limited experience of some observers. Additionally, difficult and/or expensive logistics also limited access to many nesting areas and consequently the frequency and area extent of searches at these locations. We conclude that site conditions and logistical constraints in Southeast Alaska generally preclude efficient application of standard detection methods for searching goshawk nesting areas. Because searches of nesting areas among the dense rainforests and remote locations of Southeast Alaska are inconclusive when no goshawks or nests are detected using standard detection methods, and because we experienced low detection rates of goshawks and nests using these methods at known nesting areas, we further conclude that standard detection methods are not effective for reliably monitoring the annual or long-term status of most nesting areas in this region.

During 1992–99, 57 adult goshawks, including 26 females and 29 males, were radiotagged at 28 nesting areas and tracked year-round with airplanes; 88% of females and 69% of males were relocated in ≥ 1 subsequent breeding season. Distances moved between active nests in consecutive years by these birds ranged between 0.05 and 3.20 km within the same nesting area, and 3.67–152 km between nesting areas. We defined the maximum size of nesting areas in Southeast Alaska as 804 ha (1987 ac; 3.11 mi^2), based on the maximum distance of 3.2 km that a radiotagged pair moved between active nests in consecutive years within its home range. We observed that nest sites are generally 5–15 ha (12–37 ac) and that distances separating more than one nest site within the same nesting area can range from a few hundred meters to >3 km. Of active nests found with radiotelemetry within the same nesting areas in consecutive years, 54.2% (13 of 24) were located within a 0.359 km radius and 40.5 ha (100 ac) circular area of the year 1 nest; 79.2% (19 of 24) were located within a 1.0 km radius and 314.2 ha (776.4 ac) circular area of the year 1 nest. Based on these results and the inferred low rate of active nest detection we experienced when searching nesting areas without radiotelemetry, we recommend that the minimum size of "no commercial timber harvest" buffers around goshawks nests be increased beyond the 40.5 ha (100 ac) currently specified in the TLMP if a nest and nesting area based approach to goshawk management is to be used in the future. From our data and observations, we conclude that increasing the size of buffers around known nests will provide greater integrity to nesting areas by protecting more distant (0.359–3.2 km) alternate nests that have a low probability of detection without the aid or radiotelemetry.

Mean occupancy of nest sites based on the presence of an active nest detected with or without radiotelemetry was 28.4% ± 7.6 SE per year at Southeast Alaska nesting areas monitored ≥ 5 to 9 years but varied among management areas of the Tongass National Forest (Ketchikan = 13.0% ± 9.2 SE; Stikine = 20.0% ± 13.0 SE; Chatham = 53.2% ± 15.0 SE). Nesting area fidelity and mate fidelity were moderate for radiotagged females and high for radiotagged males. This difference between sexes can be explained in part by mate abandonment and movement to different nesting areas by some females, but not by males. Eleven females moved to a different nesting area in 35.7% of consecutive year events and remained at the same nesting area 64.3% of events. All adult males remained at the same nesting areas in consecutive year events. For radiotagged pairs, both members of a pair nested at the same nesting area in 55.2% of consecutive year events, and in 75.9% of events at least one member of the same pair was present at the same nesting area. Males retained the same mate in 81.0% of (male) consecutive year events; females retained the same mate in 54.8% of (female) consecutive year events. During 1991–99, a total of 223 fledglings were observed at 113 active nests in 55 nesting areas. Mean productivity across all years was 2.0 fledglings per active nest (annual range = 1.5–2.3). Mean rate of success (≥ 1 young fledged) of active nests across all years was 93% (annual range = 87%–100%). We captured and determined the sex of 49 fledglings that represented all young known to have fledged from 23 nests at 15 nesting areas. Male/female ratio of these birds was 1.04. A total of 81 fledglings, including 40 females and 41 males, were captured at 31 nesting areas during 1992–99. We banded all of these birds and 44, including 17 males and 27 females at 24 nesting areas, were also radiotagged with tail-mounted transmitters to study their dispersal movements and survival.

Our results are of interest to Tongass land managers who need to understand the implications of timber harvest on goshawk nesting areas. Our results indicate there is a high probability that not all active goshawk nests will be detected even when goshawk surveys are conducted before and during timber sale development. In addition, movements by goshawks to alternate nests in subsequent years confound survey difficulties. We conclude that a nest-based management approach to conserving goshawks would not be successful. A landscape approach, as adopted in TLMP, that includes both unknown nesting goshawks and sufficient foraging habitat is the cornerstone to a sound, long-term habitat management plan.

Key words: *Accipiter gentilis*, forest management, mate fidelity, nest area fidelity, nest productivity, nest success, northern goshawk, raptor, Queen Charlotte goshawk, Tongass National Forest, radiotelemetry.

TABLE OF CONTENTS

BACKGROUND

During 1991–99 the Alaska Department of Fish and Game (ADF&G) and the USDA Forest Service (USFS) conducted a study of northern goshawk (*Accipiter gentilis*) (hereafter "goshawk") ecology and habitat relationships on the Tongass National Forest in Southeast Alaska. This study was initiated from the need to focus applied ecological studies of the goshawk on the Tongass National Forest to meet requirements of The National Forest Management Act of 1976, which directs the USFS to manage wildlife habitats so that viable vertebrate populations are maintained in a well-distributed manner on National Forestlands. In the early 1990s, concerns about the effects of timber harvest on goshawk populations were first publicized in the southwestern U.S. (Crocker-Bedford 1990), and the U.S. Fish and Wildlife Service subsequently called for a nationwide status review of the species (Federal Register 1991 and 1992). Committees of biologists also identified the goshawk as a species with population viability concerns in Southeast Alaska due to the high levels of timber harvest in this region (Crocker-Bedford 1992, Suring et al 1992). The goshawk was identified as a species of special interest and one in need of study on the Tongass National Forest. The Southeast Alaska population of the northern goshawk is listed as a species of special concern by the Alaska Department of Fish and Game. This species was chosen for study because of its affinity for forested landscapes, its association with larger and more mature forests in the Pacific Northwest (e.g., Reynolds et al. 1992, Squires and Reynolds 1997), its association with large habitat patches (Widen 1989), and the unique Queen Charlotte subspecies (*A.g. laingi*) that occurs in Southeast Alaska (Taverner 1940, American Ornithologists Union 1957, Palmer 1988, Webster 1988, Johnson 1989, Whaley and White 1994). Additionally, before the current study almost no information existed about the goshawk, its populations, or status in Southeast Alaska, and it was recognized that most knowledge of the species' relative abundance and habitat associations from other portions of its range is probably not applicable to the coastal rainforest environment of this region (ADF&G 1992).

Project goals and objectives were first identified in the 1992 ADF&G–USFS project study plan (ADF&G 1992). Objectives were broad in the beginning years of study when the base knowledge of goshawk natural history in Southeast Alaska was limited. For example, only 4 active nests at 10 documented historic and current nesting areas were known on the entire Tongass in 1992, the first full field season of effort. We accumulated some baseline data after several field seasons, allowing goals and objectives to be refocused and revised in updated study plans (ADF&G 1996).

OBJECTIVES

We focused on developing adequate samples of nesting areas and radiotagged goshawks and on determining the annual status and productivity of known nesting areas. We examined goshawk diet during the nesting season and assisted MS candidate Steve Lewis in his study of this objective. We also continued to collect and analyze morphometric data to assess the subspecific status of goshawks in Southeast Alaska.

Objective 1: Determine annual occupancy, nesting status, and productivity of known nesting areas.

Objective 2: Locate additional goshawk nesting areas to increase sample size.

Objective 3: Determine home ranges, habitat associations, and interyear movements of goshawks using radiotelemetry.

Objective 4: Evaluate goshawk diet during the nesting period.

Objective 5: Assess subspecific status of goshawks in Southeast Alaska.

STUDY AREA

Our study area was approximately 77,000 km^2 (about 160 x 480 km; 30,000 mi^2) and encompasses most of the Tongass National Forest in Southeast Alaska, including major portions of the Ketchikan, Stikine, and Chatham Management Areas and 8 of their 10 ranger districts. Goshawks occur in low densities in Southeast Alaska and are difficult to study in the dense temperate rainforests covering this vast region of island archipelagos and mountainous terrain (ADF&G 1993 and 1997, Schempf et al. 1995). Goshawks are also wide-ranging and secretive raptors and are essentially impossible to study away from the immediate vicinity of nest sites in Southeast Alaska without the aid of radiotelemetry (hereafter "telemetry"). In pursuing the goals and objectives of this project, we focused field efforts during 1991–1999 on locating active goshawk nests and developing and maintaining a sample of radiotagged adults over time. We derived nearly all study data from active nests, which allowed us to gather nest-based information on goshawk natural history and ecology and which served as loci where we could capture and radiotag adults and fledglings to investigate their movements, habitat use, and survival. New nesting areas were nearly always confirmed by the discovery of an active nest, and, once identified, these areas were added to the pool of known nesting areas monitored annually to assess nesting activity and productivity. At nesting areas monitored with telemetry, we were able to objectively assess annual occupancy, site and mate fidelity, and movement between alternate nests.

METHODS

Most nesting areas were identified from observations of goshawks and nests reported by USFS personnel conducting wildlife inventory, fisheries, stand exam, or engineering field activities related to timber sales. Other nesting areas were identified from observations by agency biologists conducting goshawk or songbird surveys, from observations by individuals engaged in recreational and other incidental activities, or from historic nest site records. We also tracked radiotagged adult goshawks to previously unknown nesting areas. We did not use random, systematic, or complete searches to identify new nesting areas (e.g., Reynolds and Joy 1998), nor did we attempt to test the efficacy of goshawk detection methods at known nest sites or nesting areas (e.g., Kennedy and Stalecker 1993, Watson et al. 1999).

Methods used to locate new nesting areas and to assess the status of known nesting areas were divided into 2 basic types: searches aided by telemetry and searches not aided by telemetry. Telemetry-aided searches were used whenever a radiotagged adult from a previous year could be tracked during a later breeding season. These efforts included aerial relocation followed by ground-based relocation of transmitters. Telemetry-aided searches located tagged adult females and males that moved between alternate nests within the same nest stand or nesting area, or that were present at the same nesting area but did not nest. These searches also located radiotagged adult females that moved to other distant areas where they did or did not nest. This is unlike many other goshawk studies that do not use telemetry and have much lower probability of locating nesting goshawks that may have moved out of an intensively searched study area or moved a long distance to alternate nests within the same home range (e.g., Woodbridge and Detrich 1994, Reynolds et al. 1994).

Nesting area searches done without telemetry occurred when no adult goshawk wearing an active radio tag was present at a known or suspected nesting area. The method we used most frequently to assist detection of active nests was broadcasting recordings of conspecific vocalizations to elicit vocal or other responses from goshawks (e.g., Kennedy and Stalecker 1993). Other search methods included observing forested areas from vantage points to detect goshawks in flight above the canopy (e.g., Kostrzewa and Kostzewa 1990), listening for unsolicited goshawk vocalizations (e.g., Pentriani 1999), and accessing nesting areas and surrounding areas by foot (e.g., Fuller and Mosher 1987), vehicle, and boat to search for evidence of nesting. During searches done without telemetry at known nesting areas, all known nests were first inspected for activity. If these nests were determined inactive, variable effort was then applied to the surrounding area. Search effort without telemetry varied considerably between years, nesting areas, number of area visits, duration of visits, time in breeding season, number and experience of personnel, and extent of area searches. The number of visits made to a nesting area during a breeding season and the resulting degree of search effort was dictated largely by the remoteness of a location and logistical and cost considerations. We did not attempt to precisely document, summarize, or analyze effort or other method variables for nest searches done without telemetry. Access to many nesting areas we studied required travel by aircraft or boat and was therefore limited by unfavorable weather and cost. We summarized methods of transportation used to access field sites to examine how these logistics affected our ability to monitor nesting areas.

Annual Monitoring of Nesting Areas

ADF&G or USFS biologists and technicians made 1 to >10 visits to most documented nesting areas each year during the breeding season, March 1 to August 15, to determine occupancy, nesting status, and productivity and to collect site data. We summarized results of nesting area annual monitoring efforts for the period 1991–1999. Summary by year was done by tallying the number and proportion of nesting areas known from a previous year that were searched with and without telemetry and the outcome of these searches. Not included in this summary were nesting areas where no active nest had been located in any year, nesting areas where the status of both radiotagged adults from a previous year was "dead" or "unknown," and nesting areas that were first documented in 1999. As noted, we did not attempt to directly compare search methods at nesting areas during monitoring efforts, nor did we attempt to first locate nests without telemetry when radiotagged adults were present at a nesting area.

Distances Moved Between Nests

We examined the distances moved between nests by identifying all occasions in which an active nest was located at the same nesting area in 2 consecutive years. We also identified all occasions that a radiotagged adult moved to a different nesting area and nested there in year 2 of consecutive breeding seasons. Distance between each pair of year 1 and year 2 active nests was measured using USGS topographic maps, aerial photos, or GIS map software. Data was divided into 2 groups: second year nests located with telemetry and second year nests located without telemetry. We examined each data group separately and also made general comparisons between groups. For nests located with telemetry, the identities and home ranges of all individuals were known, and we were able to determine which second year nests were located within the same nesting area and home range and which were located in a different nesting area and home range. For nests located without telemetry, where no adult wore an active radio and many were unmarked and their identities unknown, we assumed that at least 1 member of the year 1 pair was present at the year 2 nest (i.e., the move to the year 2 nest was made by at least 1 adult from the year 1 nest). We also assumed that a second year nest located without telemetry was located within the same nesting area associated with the year 1 nest. See Results and Discussion for information supporting these assumptions.

Occupancy of Nesting Areas

During 1992–99 we monitored individual radiotagged adult goshawks year-round from <1 to 7 years. Radiotagging the adults allowed us to track movements of individuals and pairs and to determine their nesting status during 1 or more subsequent breeding seasons. To summarize adult nesting area occupancy rates, we identified all occasions in which a radiotagged individual was present in 1 or more breeding seasons at the same nesting area. Mean length of occupancy for adult females and males was then calculated for all nesting areas. We also summarized nesting area occupancy by any radiotagged adult. This nesting area-based method is different from bird-based occupancy because it also accounts for new birds replacing mates that died or left a nesting area.

Status of Adults and Pairs in Consecutive Breeding Seasons

The status of radiotagged adults and adult pairs at nesting areas during 1992–1999 was summarized using consecutive breeding seasons (see section *Distance Moved Between Nests* above). We identified all occasions in which an individual adult or an adult pair was known to be alive and nested in 1 breeding season, labeled year 1, and effort was made to determine its status during the following breeding season, labeled year 2. For individual adults, results were divided by sex and the following year into status types: 1) nested at same nesting area, 2) remained at same nesting area but did not nest, 3) moved to other nesting area and nested with a different mate, 4) moved to other nesting area and did not nest, 5) dead, and 6) unknown. Year 2 status types for pairs included 1) pair nested at same nesting area, 2) female moved to different nesting area; male remained and nested with new mate, 3) female moved to different nesting area; male remained and did not nest, 4) one mate died; remaining bird nested with new mate, 5) one mate died; remaining bird did not nest, and 6) status of 1 or both sexes unknown. We also used this information on the status of adults in consecutive years to summarize nesting area fidelity and mate fidelity.

RESULTS AND DISCUSSION

Objectives 1 and 2: Determine annual occupancy, nesting status, and productivity of known nesting areas. Locate additional goshawk nesting areas to increase sample size.

Annual Monitoring of Nesting Areas

We define *nest site* as the nest, nest tree, and forested area surrounding the nest that includes prey-handling areas, perches and roosts, and may contain ≥1 alternate nest. Nest sites in Southeast Alaska are approximately 5–15 ha. We define *nesting area* as the landscape area up to 804 ha (1987 ac; 3.11 mi^2) that includes all nest sites and alternate nests used by a goshawk pair or individual within its breeding home range. This definition is based on 8 years of our radiotelemetry data from adult goshawks in Southeast Alaska. We note that our telemetry-based definition of nesting area is analogous to the term *territory*, when used in other goshawk studies to describe the landscape area encompassing all known nests used by a pair (e.g., Woodbridge and Detrich 1994, Reynolds, et al. 1994). See Table 1 for definitions of these and other terms.

During 1991–1999, a total of 61 goshawk nesting areas were identified within an area approximately 77,000 km^2 (30,000 mi^2) in Southeast Alaska, including 4 nesting areas documented before 1991 and 57 nesting areas identified during project fieldwork in 1991–1999 (Table 2). A total of 56 nesting areas were located on Tongass National Forest land, including 14 on the Ketchikan, 26 on the Stikine, and 16 on the Chatham Management Areas; five other nesting areas were located on land of other ownership. The annual cumulative total of known nesting areas ranged from 7 in 1991 to 61 in 1999. Number of nesting areas known to have an active nest ranged from 3 in 1991 to 23 in 1999. Of the 61 nesting areas, 37 (61%) were identified through reports of goshawks and nests observed during activities associated with USFS or other timber sales. These included observations from wildlife inventory, fisheries, stand exam, or engineering crews. Six (10%) nesting areas were identified from reports from incidental observations or individuals engaged in recreational activities, and 5 (8%) were identified during agency bird surveys or goshawk project surveys. We identified 13 (21%) of the 61 nesting areas by tracking a radiotagged adult to a new nesting area. We monitored nesting areas annually by making 1 to >10 visits during the breeding season to assess occupancy and nesting status. Nesting area searches were aided by telemetry or by standard goshawk detection methods, including: broadcasting conspecific calls, watching for goshawks in flight above the canopy, listening for goshawk vocalizations, and accessing nest sites and surrounding areas on foot to search for visual clues of goshawks and nesting. We did not test the efficacy of these standard detection methods or apply them under strict protocol.

During 1991–1999, nesting areas were monitored during a total of 283 nesting area-years at 59 nesting areas. Two additional nesting areas, both located on private land, were visited by ADF&G or USFS personnel before 1991; one area contained an active nest site that was clearcut during logging activities. The other is near Skagway at the northern periphery of our study area. Nesting area monitoring included searches during 82 nesting area-years at 40 nesting areas where 1 or more radiotagged adult was present (including the year of radiotagging) and 201 nesting area-years at 51 nesting areas where no radiotagged adults were present. Primary access to nesting areas from the closest ADF&G or USFS office was facilitated by various types of motorized transportation, and access to more than half (58%) of the nesting areas used or required more than 1 type of transportation (e.g., floatplane and road vehicle). For nesting areas monitored during 1991–1999, transportation types used on 1 or more occasions were floatplanes, 68% (40); helicopters, 24% (14); boats, 27% (16); and road vehicles, 51% (30). Of those nesting areas that we used only road vehicles to gain access, eight of twelve (75%) nesting areas were on the Juneau road system. In addition to 1 or more modes of transportation, access to all nesting areas and nest sites required traversing forested areas on foot from transportation departure points (e.g., beaches, muskegs, and roads). Distances traversed on foot to nesting areas ranged from 0.05 to >3km.

Summary by Year

The following results are from annual nesting area monitoring during 1991–1999.

<u>Nesting area searches with and without telemetry</u>. A mean of 83% (annual range = 70–96%) of all nesting areas known from a previous year were searched for nesting activity with or without telemetry on at least 1 occasion during the breeding season. An active nest was located at a mean of 25% (annual range = 19%–36%) of all nesting areas searched across all years. Additionally, a goshawk and other evidence of goshawk activity, such as recent prey remains or molted feathers, were observed and an active nest was not located, or a radiotagged goshawk was present and did not nest at 20% (annual range = 4–40%) of all nesting areas searched.

<u>Nesting area searches with telemetry</u>. A mean of 14% (annual range = 0–29%) of all nesting areas known from a previous year were searched with telemetry, and an active nest was located at 77% (annual range = 40–100%) of these nesting areas. Additionally, a radiotagged goshawk was present but did not nest at 23% (annual range = 0–50%) of these nesting areas. These latter observations involved 6 adult goshawks, including 1 female and 5 males that were radiotracked at 6 nesting areas. The movements of these individuals were focused on their respective nesting areas. These movements and ground checking of telemetry relocations indicated a high confidence that nesting did not occur. The 5 adult males (Blueberry 95–96 and Eagle Creek 93–94, Douglas Is.; East Bay of Pillars 95–96, Kuiu Is.; Lace River 94–95, Juneau mainland) were abandoned (after nesting) by their mates in 1 year and remained at the same nesting area the following year but did not nest. The one adult female (Pavlof River 95–97, Chichagof Island) remained in the vicinity of her nesting area for 2 successive years and did not nest either year. Her mate was not radiotagged. All these observations were made on the Chatham Area (Table 2).

<u>Nesting area searches without telemetry</u>. A mean of 70% (annual range = 53–80%) of all nesting areas known from a previous year were searched without telemetry and an active nest was located at 16% (annual range = 9–25%) of these nesting areas. A goshawk and/or other evidence of goshawk activity were observed, and an active nest was not located at 19% (annual range = 5–40%) of these nesting areas.

These results show that from 1991–1999 most annual monitoring of nesting areas was done without the aid of telemetry and that the mean proportion of nesting areas searched with standard detection methods across all years was 70%, compared to 14% for searches with telemetry. Additionally, the mean proportion of nesting areas searched without telemetry and an active nest was located was 16%, compared to 77% for nesting areas searched with telemetry and an active nest was located. For nesting areas searched with telemetry and nesting areas searched without telemetry combined, the mean proportion across all years of all nesting areas searched was 83%, and an active nest was located at a mean proportion of 25% of these nesting areas.

We present this information as a record of extensive nesting area monitoring efforts that were conducted throughout Southeast Alaska over a 9-year period by ADF&G and USFS personnel. These results are presented by basic search types (with and without telemetry) to give a general accounting of these efforts. We caution against using these results to make direct and quantitative comparisons of the relative effectiveness of each search method for locating goshawk nests. For example, interpreting this information directly would incorrectly imply we observed a five-fold greater effectiveness of searches with telemetry (77% vs. 16%). Although a gross comparison of our field experiences with these search methods shows a relatively low success rate for nesting area searches done without telemetry (see below), we did not conduct a true test of the effectiveness of each search type; therefore, accurate comparisons of these search methods is not possible using this data set.

A primary focus of this project was to locate goshawk nests as the basis of ecological studies of this species. Our project goals and objectives did not include directly quantifying either goshawk detection rates or goshawk nesting densities. Though our data from annual monitoring of nesting areas provide a general summary of these efforts, more detailed interpretation of this data is confounded by limitations and variation in factors affecting the outcome of searches done without the aid of telemetry, such as variation in observer experience, number of nesting area visits, area extent of searches, and time in breeding season of searches. Additionally, we did not study nor attempt to account for fluctuation in natural factors, such as prey abundance and weather, which may have caused annual variation in nesting area occupancy and nesting status. Based on qualitative comparison of results from nesting area searches we conducted with and without telemetry, and analysis of data on nesting area fidelity and movement by radiotagged adults within and between nesting areas, we conclude that some significant proportion of goshawks and active nests were probably not detected during nesting area searches done without telemetry. Despite these shortcomings in our data from monitoring of nesting areas, we believe that these and other results from 9 years of study of goshawks and their nesting areas throughout Southeast Alaska nonetheless support our observations that goshawks are both uncommon in this region and nest here in densities lower than those reported for some other North American regions, such as Interior Alaska, Arizona, California, and Oregon (e.g., Squires and Reynolds 1997).

Logistical considerations were an important factor determining our ability to access and search nesting areas. Two-thirds of nesting areas we studied used floatplanes for access on 1 or more occasions, and many required more than 1 mode of motorized transportation. This is unlike most studies of goshawk nesting in other North American regions (e.g., southwestern US, California, Oregon, and Washington), where nesting area access is often entirely by vehicle and foot. Our extensive field experiences in Southeast Alaska support our belief that the temperate rainforests and remote island achipelagos of this region present one of the most challenging environments for the study of goshawks and that the dense forest structure and often inclement weather here make goshawk detection more difficult than in other regions having drier and more open forests. These considerations and our observations that goshawks appear to occur in lower densities in Southeast Alaska than in many other areas of North America indicate our data from nesting area monitoring is not directly comparable to similar data from other regions where goshawks occur in higher densities and more open forests and where nesting areas are accessible primarily by road and foot.

<u>Objective 3: Determine home ranges, habitat associations, and interyear movements of goshawks using radiotelemetry.</u>

Home Ranges

We evaluated the home range sizes of goshawks and found wide variation among individuals. These results were presented in detail in Iverson et al. 1996. Subsequent to 1996, we reanalyzed goshawk home range size using all the aerial radiotelemetry data from 1992–2000. This was done to: 1) increase the sample sizes presented in Iverson et al. (*op cit.*), 2) perform a more thorough data editing, and 3) provide additional home range estimates. These results are summarized in Tables 3 and 4.

Habitat Associations

Habitat associations were presented in Iverson et al. (1996), Alaska Department of Fish and Game (1994), and Pendleton et al. (1998).

Interyear movements

Nests Located with Telemetry

Twenty-four year 2 active nests were located with telemetry within the same nesting areas as their year 1 active nests by tracking radiotagged adults in consecutive breeding seasons. For radiotagged females and males combined, median distance moved between year 1 and year 2 nests at the same nesting area by adult goshawks was 0.23 km (inner quartile range = 0.17–0.68); mean distance was 0.73 km ± 1.00 SD (range = 0.50–3.20, n = 24 pairs of year 1 and year 2 nests used by 18 females and 11 males at 25 total nesting areas). The greatest distance that both members of a radiotagged pair moved in consecutive breeding seasons to an alternate nest within its documented home range and nesting area was 3.2 km (Margaret Lake, Revillagigedo Is. 1996–97; Table 2). We used a diameter of 3.2 km to describe the maximum area extent of nesting areas in Southeast Alaska (Table 1). A circular area having a diameter of 3.2 km is equal to 804 ha (1987 ac; 3.11 mi^2). This was also the greatest distance moved between nests in consecutive breeding seasons by a radiotagged adult male. We did not observe any radiotagged adult male move to and nest at another nesting area outside its documented breeding home range. In northern Arizona mean distance moved between alternate nests in the same territory was 0.489 km ± 0.541

SD (range = 0.021 km–3.41 km, n = 103 territories). Median distance moved between alternate nests was 0.285 km (Reynolds and Joy 1998).

We observed that all movement between active nests in consecutive breeding seasons greater than 3.2 km was made by radiotagged adult females that abandoned their year 1 mate and moved to a different nesting area in year 2 where they nested with a different mate. All movement by radiotagged females between alternate nests ≤ 3.2 km occurred within the same documented nesting area and home range. During 1992–99, 13 active nests were located by tracking an adult female to a different nesting area in year 2 of consecutive breeding seasons. Median distance moved by these birds from a respective year 1 nest was 18.50 km (inner quartile range = 7.80–36.10; range = 3.67–152 km, n = 13 nests; mean distance moved was not calculated due to the large variance of this data).

In northern California, distances moved to other territories (nesting areas) by banded adults in subsequent years averaged 9.8 km ± 2.7 SD (range = 5.5–12.9 km, n = 4) for females and 6.5 km ± 2.7 SD (range = 4.2–10.3 km, n = 3) for males (Detrich and Woodbridge 1994). In northern Arizona, distances moved to other territories by banded adults averaged 5.2 km ± 2.66 SD (range = 2.4–8.6 km, n = 5) for females and 2.8 km ± 1.06 SD (range = 2.0–3.5 km, n = 2) for males (Reynolds and Joy 1998). Unlike our study in Southeast Alaska, these studies observed that some adult males moved to and nested in areas considered different territories. As noted, nesting areas and home ranges in our study were defined with telemetry and we did not observe any adult male to move to and nest in a different nesting area outside of its documented home range. We are uncertain as to how the area extent of territories (home ranges) was defined in these other studies; however, comparing the maximum moved between nests by adult males in our study (3.2 km) with the range of distances moved by males to nests in other territories in California (4.2–10.3 km) and Arizona (2.0–3.5 km) shows that at least in California some males moved greater distances between nests than goshawks in Southeast Alaska. Similar to our study, banded adult females in these other studies were observed to move farther and more frequently than adult males. The observed range of distances and maximum distance moved by adult females between nesting areas, however, was considerably greater in Southeast Alaska than in these other regions (3.67–152 km vs. 5.5–12.9 km and 2.4–8.6 km, respectively). As with our comparisons of intra-nesting area movement between alternate nests, this difference may be explained largely by our use of telemetry to relocate adults both more consistently and at greater distances than is possible with birds marked with only bands.

The tendency for greater territory residency by males than females is widespread among bird species, including birds of prey (Greenwood 1980). Within *Accipiter* this pattern has been observed for goshawks in Southeast Alaska (this study), California (Detrich and Woodbridge 1994) and Arizona (Reynolds and Joy 1998), for Cooper's Hawks (*Accipiter cooperii*) in Wisconsin (Rosenfield and Bielefeldt 1996), and for sparrowhawks (*Accipiter nisus*) in Europe (Newton 1986). Mate abandonment and movement to other territories by females was observed in all of these studies; however, observations of this behavior in males are less consistent. Unlike Detrich and Woodbridge (*op cit.*) and Reynolds and Joy (*op cit.*), who studied goshawks 9 years and 6 years, respectively, we did not observe mate abandonment and movement to other territories or nesting areas by adult male goshawks.

Observations from our 8-year study in Southeast Alaska are consistent, however, with those for Cooper's hawks by Rosenfield and Bielefeldt (1996), who studied this species in Wisconsin over a 16-year period and observed that adult males remained at the same territories while some adult females moved to other territories. Newton (*op cit.*) studied sparrowhawks over a 14-year period and observed mate abandonment and movement to other territories by both males and females. He suggests that greater residency by males may be related to maintaining territories and observed that adult male sparrowhawks appear to be the prime defenders of nesting areas and home ranges where they procure food to support the female and young during the breeding season.

Nests Located without Telemetry

For the group of nests located without telemetry in year 2 of consecutive breeding seasons, all adults were 1) unmarked and their identities unknown, 2) banded and not wearing a radio tag, or 3) banded and wearing an inactive radio tag. Marked birds in this group could be positively identified only if captured. We assume that for nests located in year 2 without telemetry that at least 1 member of the year 1 pair was present at the year 2 nest and that the year 2 nest is located within the home range of the year 1 pair. That is, we assume that the year 1 and year 2 nests are within the same nesting area and occupied by at least 1 member of the same pair. These assumptions have been commonly used in other studies that examined nesting area occupancy and movement between alternate nests by unmarked goshawks (e.g., Reynolds and Wight 1978, Crocker-Bedford 1990). Additionally, in our study we believe these assumptions are supported in part by the observation that the maximum distance moved between nests by adults in this group (no telemetry) is within the maximum intra-nesting area distance moved between alternate nests by a radiotagged adult (1.6 and 3.2 km, respectively). Also, at some nesting areas where adults wore expired radio tags and/or were banded, we did confirm the presence of individuals at a nesting area in consecutive breeding seasons when they were recaptured. Though other data in our study indicate a relatively low success rate for nesting area searches done without telemetry (which weakens the validity of our data set representing the distances moved to year 2 nests located without telemetry), we present these results to allow general comparison of this data with data from the group of nests located with telemetry.

For the 19 active nests located without telemetry in year 2 of consecutive breeding seasons, median distance from a respective year 1 nest was 0.35 km (inner quartile range = 0.25–0.50 km); mean distance = 0.46 km ± 0.42 SD (range = 0 [same nest reused] –1.60 km). Of these 19 year 2 nests, 53% (10 of 19) were located within 0.359 km and a 40.5 ha (100 ac) circular area of their respective year 1 nests, and 84% (16 of 19) were located within 1.0 km and a 314.2 ha (776.4 ac) circular area of their respective year 1 nests. Comparison of year 2 nests located with and without telemetry shows that the maximum distance moved from respective year 1 nests at the same nesting area was 2 times as great (3.2 vs. 1.6 km, respectively) for radiotagged adults as for unmarked adults, banded only, or banded and wearing an inactive radio tag. Although year 2 nests located with telemetry within the same nesting area and >1.6 km from the previous year's nest represent only 17% (4 of 24) of this intra-nesting area group, these more distant moves to alternate nests emphasize both the mobility possible by goshawks within a nesting area and the potential for more distant alternate nests to go undetected in searches without telemetry. Additionally, due to limitations in factors affecting the success of nest searches done without telemetry during 1991–99, such as experience of some observers, number of nesting area visits, area extent of searches, and time in breeding season of searches, we believe that some significant portion of active alternate nests were probably not located during year 2 searches using this method. We believe this is probably especially true for active alternate nests > 0.4 km from inactive known nests, which were most often the starting points for nest searches during annual monitoring efforts at nesting areas done without telemetry.

Occupancy of Nesting Areas

Radiotagged Adults

Telemetry allowed us to directly locate birds that moved to alternate nests within the same nesting area (0.05–3.2 km), birds that moved to other nesting areas (>3.2–152 km), and birds that were present at a nesting area but not nesting. We considered a nesting area occupied when a radiotagged adult was present on ≥ 1 occasion during the breeding season March 1–August 15, including the breeding season in which an individual was first radiotagged or first moved to a new nesting area. We counted 1 year of occupancy when a radiotagged adult was present during the breeding season in a year beginning March 1 and ending February 28 of the following calendar year. For each adult female and each male, we counted the total years of occupancy and then calculated mean occupancy for all nesting areas for each sex. This method of summarizing occupancy is similar to that used by Woodbridge and Detrich (1994), who counted the first breeding season of presence and each subsequent breeding season of presence at a nesting area as 1 "year" of territory occupancy. In our study of radiotagged goshawks, in most cases we monitored adults year-round and detected presence within a nesting area or home range at different times of the year. Though occupancy is expressed here in "years" of presence, because the measure used is actually presence at a nesting area during the breeding season, it may be more accurate to express these results as "breeding seasons" of presence.

During 1992–1999 mean nesting area occupancy by radiotagged adults was 1.6 years ± 1.0 SD (range = 1–6, n = 26 birds at 29 nesting areas) for females, and 1.9 years ± 1.4 SD (range = 1–7, *n* = 28 birds at 25 nesting areas) for males. These occupancy estimates include data from 11 females that made a total of 13 moves to other nesting areas (>3.2 km), where occupancy was counted anew. Mean nesting area occupancy by only adult females that remained at the same nesting area was 1.6 years ± 0.7 SD (range = 1–3, n = 26 birds at 19 nesting areas). We did not document any moves to other nest areas by adult males. In northern California, colored leg bands were used to identify adults at nest sites and assess annual territory (nesting area) occupancy. Territory occupancy averaged 1.8 years ± 1.3 SD (range = 1–7 years, *n* = 40 birds) for adult females, and 1.3 years ± 0.54 SD (range = 1–3 years, *n* = 27 birds) for adult males. Fifty-three percent of adult females and 60% of adult males were not relocated in years subsequent to the year of banding (Detrich and Woodbridge 1994). In northern Arizona, territory occupancy averaged 1.88 years for banded adult females (range = 1–6) and 1.42 years for banded adult males (range = 1–6) (Reynolds and Joy 1998).

Studies using banded birds tend to underestimate actual occupancy rates because of difficulties with locating birds that move to more distant alternate nests or that leave a nesting area and with locating birds present at a nesting area but not nesting. Banded adult males in these studies are also often more difficult to identify than their nest-attending mates because they are frequently foraging away from the nest. Males are also generally less aggressive and therefore less visible than females at the nest site.

Goshawk researchers have traditionally considered observation of 1 or more adults at a nesting area during the breeding season as minimum evidence of occupancy (e.g., Crocker-Bedford 1990). Although we also used this criterion in our study, we did not attempt to estimate nesting area occupancy using this information because we believe detection of goshawks in the rainforest environments of Southeast Alaska is sufficiently low when not aided by telemetry and, therefore, confidence in this estimate is precluded. We could not conclude with high confidence that a nesting area was unoccupied or inactive when no goshawk was detected. To further summarize our efforts to monitor nesting area activities over time, we examined the presence of any radiotagged adult at nesting areas in 1 or more breeding seasons. This method differs from the above analysis that considers occupancy by individual radiotagged adult females and males. At 28 nesting areas monitored during 1992–1999, we observed 33 exclusive occupancy events in which 1 or more radiotagged adults were present at the same nesting area during 1–7 sequential breeding seasons. Of these 33 events, presence by radiotagged adults at nesting areas was distributed as follows (1 = one breeding season, including season of initial radiotagging; 7 = seven sequential breeding seasons): 1 = 15 (45%), 2 = 10 (30%), 3 = 5 (15%), 4 = 1 (3%), 5 = 0 (0%), 6 = 1 (3%), and 7 = 1 (3%). We observed more than 1 single-year or multiple-year event, separated by 1 or more years of apparent inactivity, at only 2 nesting areas. Mean nesting area occupancy by any radiotagged adult during 1992–99 was 2.03 years ± 1.42 SD (range = 1–7 years, n = 56 nesting attempts and 6 occasions of presence only at 27 nesting areas).

Our results show that most (75% of events) nesting area occupancy by radiotagged adults occurred during the first 2 breeding seasons of sequential year use and that few nesting areas were occupied by radiotagged adults for more than 3 sequential breeding seasons. Goshawk studies in other North American regions have observed that most nest sites are occupied from 1 to 3 years and some much longer (Squires and Reynolds 1997). Various factors limited our ability to monitor many goshawks over multiple years. These included factors related to our study methods, such as transmitter failure or normal battery expiration (9–24+ mos., depending on type), loss of tail-mounted transmitters during molt, inability to recapture and retag some trap-shy birds, and inability to relocate some birds due to transmitter failure and/or movement outside of our study area. Other factors related to goshawk survival and behavior were mortality and movement by some adult females to other nesting areas. Consequently, presence of radiotagged adults at nesting areas decreased over time, and we were unable to assess occupancy and nesting activity with telemetry at most nesting areas for more than a few sequential breeding seasons. We estimated annual survival of radiotagged adult females and males (combined) to be 0.72, with a 95% CI of 0.56–0.88 (Iverson, et al. 1996). These results are comparable to those reported for northern Arizona where survival of banded adult females and males during 6 years of study was estimated at 0.866 and 0.688, respectively (Reynolds and Joy 1998).

Our data also show that adult females in Southeast Alaska experience higher survival rates than adult males. These results will be presented in future reports.

Adults without Radio Tags

We documented nesting by unmarked adults in multiple (>2) breeding seasons at the same nesting area in Southeast Alaska on only 1 occasion during 1991–1999. This occurred at the Duffield Peninsula, Baranof Island nesting area (see Table 2), which is also the only location where we observed reuse of the same nest in sequential years. At this nesting area, unmarked adults successfully used the same nest for 3 sequential years during 1994, 1995, and 1996. Goshawks typically alternate between 2 or more nests within the same nest stand or nesting area (e.g., Reynolds and Wight 1978). That we observed reuse of the same nest in only 2 of 51 (4%) occasions where an active nest was located at the same nesting area in consecutive breeding seasons emphasizes the importance of alternate nests in the nesting behavior of goshawks in Southeast Alaska (Table 2). The reason that goshawks alternate between nests within a nesting area is unknown; however, it is thought that nest-switching may reduce exposure to disease and parasites (Squires and Reynolds 1997).

We believe our inability to locate many nests of unmarked adults in years subsequent to documented nesting is due partly to the relatively low rate of success we experienced while conducting nest searches at known nesting areas without telemetry (see *Annual Monitoring of Nesting Areas*). Results of these searches were also affected by the relative preponderance of radiotagged adults at the known nesting areas we studied. This was due to emphasis on our objective to develop and maintain a sample of radiotagged adults, which sometimes reduced opportunities to search nesting areas in subsequent years without telemetry, especially during 1–3 years after initial detection of nesting. For example, during 1992–1999, ≥ 1 radiotagged adult was present during at least 1 breeding season at 63% (27 of 43) nesting areas that were first discovered without telemetry. Additionally, many nesting areas were occupied by radiotagged adults in more than 1 year because we retagged some individuals over periods of ≥ 2 years and newly tagged other individuals that replaced abandoned or dead mates. Consequently, in combination with the inferred low success for nest searches done without telemetry, one effect of our radiotagging efforts was that at many nesting areas the known presence of untagged, nesting adults was often limited to the breeding season of initial nest detection, followed by subsequent years of occupancy by 1 or more radiotagged adults. In some cases, however, we documented unmarked adults nesting at areas previously occupied by radiotagged birds. This occurred when a radiotagged adult female abandoned her mate and was replaced in the following year by a new untagged female that nested with the previous year's untagged adult male. In these instances we were successful at locating the untagged pair's active nest by simply checking a previously known nest or by broadcasting conspecific calls or listening for calls at dawn.

We were unable to quantitatively summarize nesting area occupancy and nesting status by unmarked adults over multiple years due to our inability to confidently make these determinations without telemetry. At some nesting areas we documented periods of apparent inactivity of 1 to 7 years that were both preceded and followed by discovery of an active nest occupied by unmarked birds. At other nesting areas during these intermediate years, no activity was detected during some years, while during other years goshawks were detected and no nest was located (Table 2). Within the smaller area of a nest site in Southeast Alaska (typically no more than 15 ha, or 218.5 m radius; see *Definitions*), we believe the accuracy of our efforts to detect active nests without telemetry was high. For nesting areas monitored ≥ 5 to 9 years, we observed that mean occupancy (active nest present) of known nests sites was 28.4% ± 7.6 SE per year (*n* = 40 active nests located during 141 nest site-years at 23 nesting areas; nest sites searched with telemetry and without telemetry pooled). We note, however, that mean nest site occupancy varied considerably from south to north among the management areas of the Tongass National Forest: Ketchikan Area = 13.0% ± 9.2 SE (*n* = 7 active nests located during 54 nest site-years at 8 nesting areas); Stikine Area = 20.0% ± 13.0 SE (*n* = 8 active nests located during 40 nest site-years at 6 nesting areas); Chatham Area = 53.2% ± 15.0 SE (*n* = 25 nests located during 47 nest site-years at 9 nest areas). We cannot explain this variation, but note that in the Chatham Area, nest sites within 3 of 9 nesting areas, Blueberry Hill, Fish Creek, and Ready Bullion, Douglas Island, accounted for more than half of nest site-years in which an active nest was present and therefore inflated the mean occupancy estimate for this area. Additionally, one nesting area, Fish Creek, Douglas Island, was the location of the longest duration of sequential years at the same nesting area that we observed in Southeast Alaska (6 years at 2 nest sites). We also note that the Blueberry Hill, Fish Creek, and Ready Bullion, Douglas Island nesting areas are all located within an approximate 3500-ha area (8648 ac; = 13.5 mi^2) and represent the highest nesting area density we observed in Southeast Alaska during 1991–1999 (Table 2). We hypothesize that this relatively high nesting density may be related to higher prey abundance or prey availability in this region of Southeast Alaska (Lewis 2001). In northern California, nest stands in territories that were monitored ≥ 5 years were occupied an average of 46% ± 6 SE of the time (*n* = 71 nest stands; Woodbridge and Dietrich 1994). In Interior Alaska, annual nest site occupancy ranged from 6 to 56% (*n* =16 nest sites; McGowan 1975), and in Oregon mean occupancy of nest sites was 40% (*n* = 63 nest sites; Reynolds and Wight 1978).

Objective 4: Evaluate goshawk diet during the nesting period.

This objective was met and resulted in the M.S. thesis of Lewis (2001) and is summarized in the Appendix.

Objective 5: Assess subspecific status of goshawks in Southeast Alaska.

This objective was met and we conclude that the *Accipiter gentilis laingi* continues to warrant subspecific status. Abstracts of papers presented on the subspecific status of Southeast Alaska goshawks are presented in the Appendix.

CONCLUSIONS AND RECOMMENDATIONS

Our results from studying and monitoring nesting areas during 1991–1999 indicate that nesting area searches done without the aid of telemetry provided us with limited success in accurately assessing goshawk occupancy and nesting status. This observation is supported by our field observations and quantitative data on nesting area fidelity and movement of radiotagged adults between nests and nesting areas. Nesting area searches we conducted without the aid of telemetry used standard methods for detecting goshawks: broadcasting conspecific calls, watching for goshawks in flight above the canopy, listening for goshawk vocalizations, and accessing nest sites and surrounding areas by foot. Although we did not test the efficacy of these methods or apply them under strict protocol, we conclude from 9 years of field experience that because nesting areas in Southeast Alaska occur in dense rainforest conditions, in large areas (up to 804 ha), and often in remote locations requiring expensive logistics, it is generally not possible to efficiently access and search these areas or detect goshawks and their nests here with consistency using these methods. An important objective of annual nesting area searches was to locate active nests where we could collect information on goshawk nesting ecology and where we could capture and radiotag goshawks. We were largely successful in meeting this objective, given the hindrances to effective goshawk detection and site access we encountered. However, because we were unable to confidently determine that nesting areas were unoccupied or inactive when no goshawks or active nests were detected during searches without the aid of telemetry, we conclude that it is not possible to accurately interpret results from these searches within the context of monitoring long-term trends in nesting area occupancy and nesting status.

Because our data indicate that annual nesting area searches that used standard goshawk detection methods were often ineffective, unreliable, and often expensive due to aircraft and other transportation requirements at many locations, we recommend that surveys based solely on standard goshawk detection methods be discontinued in future monitoring. If monitoring of goshawk nesting areas is to be included as part of future forest management plans, we suggest a more limited approach be taken that focuses on assessing only long-term status of known nest sites (5–15 ha), where confidence in the outcome of searches is high and more indicative of goshawk nesting area occupancy. Our data show that nesting areas were typically occupied by radiotagged adults for at least 2–3 sequential years (mean = 2.03 years ± 1.42 SD, range = 1–7 years), that a large proportion of adults present in the same nesting area in consecutive years nested, and that reoccupancy and nesting at a nest site can occur after a few to 7–8 years of inactivity. Based on this information, we believe that visiting nest sites every 2 or 3 years may be suitable for generally assessing the long-term status of nesting areas. Our field experience indicates that 1 visit per nest site by experienced observers during an optimal time in the breeding season (June–July) would be sufficient to accurately assess nesting status and productivity of known nest sites and to select adjacent areas. These 1-day visits would provide opportunities for attempting to detect goshawks and nests in the selected areas adjacent to known nest sites by broadcasting conspecific calls or making observations from vantage points. Any detections would be noted for future monitoring at these sites. Alternating nest site visits at different nesting areas in different years would allow reduction in annual logistics costs. Finally, we recommend that the size of "no commercial timber harvest" buffers around known nests be increased beyond the 40.5 ha (100 ac) minimum size currently specified in the Tongass National Forest management plan. Based on our data from radiotagged adults, we conclude that increasing the size of buffers around known nests will provide greater integrity to nesting areas by protecting more distant (0.359--3.2 km) alternate nests that have a low probability of detection without the aid of radiotelemetry.

ACKNOWLEDGMENTS

The success of this project is due largely to substantial cooperative effort between the Alaska Department of Fish and Game, the USDA Forest Service, and the US Fish and Wildlife Service and their staff. Funding was provided by the Alaska Department of Fish and Game; various offices of the USDA Forest Service, including the Regional Office, Tongass National Forest, and Juneau Forestry Sciences Laboratory of the Pacific Northwest Research Station, and the US Fish and Wildlife Service's Ecological Services and Section 6 – Endangered Species offices. The Forest Service's regional office in Juneau, the Ketchikan, Stikine, and Chatham area offices, and especially the Craig, Hoonah, Ketchikan, Juneau, Petersburg, Sitka, Thorne Bay, and Wrangell ranger districts provided important logistical, technical, and staff support. Cole Crocker-Bedford, Chris Iverson, Gene DeGayner, and Terry Shaw were instrumental in providing administrative support and study direction that made this difficult project a reality. Numerous other Forest Service permanent and seasonal staff assisted with fieldwork and data management that was crucial to project success over the years, including: Kurt Aluzas, Melinda Anderman, Elizabeth Bella, Stewart Bentley, Steve Blatt, Joachim Bilanchio, Philip Bordelon, Steve Borrego, Jim Brainard, Mike Brown, Kerry Burns, Dennis Chester, Robert Clair, Joe Doerr, Dan Donato, Doug Clark, Michelle Dragoo, Marla Dillman, Galia Ely, Laura Elze, Judy Falk, Duanne Fisher, Gary Fisher, Cheri Ford, Vince Franke, Byron Gardner, Ron Gendreau, Chuck Gibilisco, Sue Green, John Haddix, Cindy Hartman, Moira Ingle, Libby Kvaalen, Melinda Kuharich, Bill Lorenz, Don Marten, Melissa Moede, Matt Meyers, Chuck Parsley, Scott Posner, Peg Robertson, Amy Russell, Kris Rutledge, Jeff Stoneman, Terry Suminski, Kris Sundeen, Leslie Swada, Shelly Szepansski, Marnique Towns, Peter Walsh, Dave Wetzel, Kristian Wood, Don Youke. We also thank Richard Guehl for his support as skipper of the USFS MV Tongass Ranger. Phil Schempf and John Lindell of the Fish and Wildlife Service provided important oversight and review over the years; Mike Jacobsen, Susan Patla, and Kurt Merg assisted with fieldwork. Mark Fuller of the USGS provided appreciated insights and advice. Jack Gustafson of ADF&G was instrumental in initiating this cooperative project with the USFS. LaVerne Beier, Gail Blundell, Jim Cariello, Steve Heinl, Doug Larsen, Dennis LeMond, Matt Robus, and Tom Schumaker of ADF&G assisted with collection of radiotelemetry data and fieldwork, as did graduate students Chris Farmer and Steve Lewis. ADF&G biologists Grey Pendleton, Rod Flynn, and Dave Person assisted with data analysis. We also thank the many pilots, air services and their staff that assisted with collection of radiotelemetry data and logistical support, including: Lynn Bennett, Brent Kennedy, Jim Wallace, Dennis Vorphal, Jim Berg, Mike Denker, Gordy Arteaga, Brian Morris, and Jennifer Muellner – L.A.B. Flying Service; Ken Jouppi – Ken Air; Butch Williams – Kupreanof Flying Service; Dave Doyon – Misty Fjords Air; Michelle Masden – Island Wings; Rod Judy, Dave Riemer, and Cole Rhoden – Pacific Wing Air Charters; Doug Riemer – Nordic Air, Pro-Mech Air, Taquan Air, Wings of Alaska, and Temsco Helicopters. Additional thanks go to Kim Middleton, Vicky Vosberg, Scott Ford, Dick Griffin, and Joanne Lubert of the Alaska Raptor Rehabilitation Center in Sitka and to Noele Weemes and Scot Tiernan of the Juneau Raptor Center.

LITERATURE CITED

Alaska Department of Fish and Game. 1992. Goshawk habitat relationships on the Tongass National Forest. Study Plan. Div. of Wildlife Conservation, Southeast Regional Office, Douglas, AK. 19 pp.

Alaska Department of Fish and Game. 1993. Ketchikan forest raptor study final report. A summary of survey, radiotelemetry, and other results regarding goshawks field studies in Southeast Alaska.. Div. of Wildlife Conservation Southeast Regional Office, Douglas, AK. 36 pp.

Alaska Department of Fish and Game. 1996. Goshawk habitat and population ecology on the Tongass National Forest. Study Plan. Div. of Wildlife Conservation, Southeast Regional Office, Douglas, AK. 21 pp.

Alaska Department of Fish and Game. 1997. Goshawk Ecology and Habitat Relationships on the Tongass National Forest. 1996 Field Season Progress Report. Div. of Wildlife Conservation, Southeast Reg. Office, Douglas, AK. 23 pp.

Crocker-Bedford, D.C. 1990. Goshawk reproduction and forest management. Wildl. Soc. Bull. 18:262–269.

Crocker-Bedford, D.C. 1992. A conservation strategy for the northern goshawk on the Tongass National Forest. *In* L.H. Suring and L.C. Shea, eds. Conservation of old growth forest wildlife in Southeast Alaska. USDA Forest Service, Alaska Region. Admin. Doc.

Detrich, P.J., and B. Woodbridge. 1994. Territory fidelity, mate, fidelity, and movements of color-marked northern goshawks (*Accipiter gentilis*) in the southern Cascades of California. Stud. Avian Biol. 16:130–132.

Federal Register. 1991. Management guidelines for the northern goshawk in the Southwestern Region. 56:51672–51680.

Federal Register. 1992. Endangered and threatened wildlife and plants: notice of 90-day finding on petition to list the northern goshawk as threatened or endangered in the southwestern United States. *Federal Register*. 57: 546–548.

Fuller, M. R. and J. A. Mosher. 1987. Raptor survey techniques. Pages 35–67 in B. A. Giron Pendleton, B. A. Millsap, K. W. Cline and D. M. Bird, editors. Raptor management techniques manual. National Wildlife Federation, Washington, D.C., USA.

Greenwood, P.J. 1980. Mating systems, philopatry and dispersal in birds and mammals. Anim. Behav. 28: 1140–1162.

Iverson, G.C., G.D. Hayward, K. Titus, E. Degayner, R.E. Lowell, D.C. Crocker-Bedford, P.F. Schempf, and J. Lindell. 1996. Conservation assessment for the northern goshawk in southeast Alaska. USDA Forest Service. Publ. PNW-GTR-387.

Johnson, D.R. 1989. Body size of northern goshawks on coastal islands of British Columbia. Wislon Bull. 101(4):637–639.

Kennedy, P.L., and D.W. Stahlecker. 1993. Responsiveness of nesting northern goshawks to taped broadcast of three conspecific calls. J. Wildl. Manage. 57:249–257.

Kostrzewa, A., and R. Kostrzewa. 1990. The relationship of spring and summer weather with breeding performance of the buzzard *Buteo buteo*, goshawk *Accipiter gentilis* and kestrel *Falco tinnunuculus.* Ibis 132:550–559.

Lewis, Stephen B. 2001. Breeding season diet of northern goshawks in Southeast Alaska with a comparison of techniques used to examine raptor diet. Thesis. Boise State University. Boise, Idaho. 125pp.

McGowan, J.D. 1975. Distribution, density and productivity of goshawks in interior Alaska. Fed. Aid Wildl. Restor. Proj. Rep. W-17-4, W17-5, W-17-6, Job 10.6A. Alaska Dept. of Fish and Game.

Newton, I. 1986. The sparrowhawk. T&A D Poyser Ltd., Staffordshire, Engl. 396 pp.

Palmer, R.S. 1988. Northern goshawk. Pages 355–378 *in* Handbook of North American birds. R.S. Palmer, ed. Yale Univ. Press. New Haven, Ct.

Pendleton, G.W., K. Titus, E. DeGayner, C.J. Flatten, and R.E. Lowell. 1998. Compositional analysis and GIS for study of habitat selection by goshawks in southeast Alaska. Journal of Agricultural, Biological, and Environmental Statistics 3:280–295.

Penteriani, V. 1999. Dawn and morning goshawk courtship vocalizations as a method for detecting nest sites. J. Wildl. Manage. 63:511–516.

Reynolds, R.T., and H.M. Wight. 1978. Distribution, density, and productivity of accipiter hawks breeding in Oregon. Wilson Bull. 90: 182–196.

Reynolds, R.T., E.C. Meslow, and H.M. Wight. 1982. Nesting habitat of coexisting accipiter in Oregon. J. Wildl. Manage. 46:124–138.

Reynolds, R.T., S.M. Joy, and D.G. Leslie. 1994. Nest productivity, fidelity, and spacing of northern goshawks in northern Arizona. Stud. Avian Biol. 16:106–113.

Reynolds, R.T. and S.M. Joy. 1998. Distribution, territory occupancy, dispersal, and demography of northern goshawks on the Kaibab Plateau, Arizona. Final Report for

Arizona Game and Fish Heritage Project No. 194045. USDA Forest Service, Rocky Mountain Research Station and Arizona Game and Fish.

Rosenfield, R.N. and J. Bielefeldt. 1996. Lifetime nesting area fidelity in male Cooper's hawks in Wisconsin. Condor 98:165–167.

Schempf, P. F., K. Merg, S. Patla, L. Daniel and M. Jacobson. 1996. Goshawk surveys in wilderness and roadless areas of southeastern Alaska, 1995. Unpubl. Rep. U.S. Fish and Wildlife Service, Juneau, Alaska.

Squires, J.R., and R.T. Reynolds. 1997. Northern Goshawk (*Accipiter gentilis*). *In* The Birds of North America, No. 298 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, D.C.

Suring, L., D.C. Crocker-Bedford, R.W. Flynn, C. Hale, G.C. Iverson, M.D. Kirchhoff, T.E. Schenck, II, L.C. Shea, and K. Titus. 1992. A strategy for maintaining well-distributed viable populations of wildlife associated with old-growth forest in Southeast Alaska. Report by an interagency Committee. Alaska Dept. of Fish and Game, Juneau, AK.

Taverner, P. A. 1940. Variation in the American goshawk. Condor 42:157–160.

U.S. Forest Service. 1997. Land and resource management plan–Tongass National Forest. U.S. Department of Agriculture. R10-MB-338dd.

Watson, J.W., D.W. Hays, and D.J. Pierce. 1999. Efficacy of northern goshawk broadcast surveys in Washington state. J. Wild. Manage. 63:98–106.

Webster, D. J. 1988. Some bird specimens from Sitka, Alaska. The Murrelet. 69:46–48.

Whaley, W. H., and C. M. White, 1994. Trends in geographic variation of Cooper's hawk and northern goshawk in North America: a multivariate analysis. Proceedings of the Western Foundation of Vertebrate Zoology. Vol. 5, No. 3:161–209.

Woodbridge, B., and P.J. Detrich. 1994. Territory occupancy and habitat patch size of northern goshawks in the southern Cascades of California. Stud. Avian Biol. 16: 83–87.

PREPARED BY: **APPROVED BY:**

Craig Flatten Wildlife Biologist I	__________________________ Wayne L Regelin, Director Division of Wildlife Conservation
Kimberly Titus Regional Supervisor	
Richard Lowell Wildlife Biologist II	

SUBMITTED BY:

Kimberly Titus Regional Supervisor	__________________________ Steven R Peterson, Senior Staff Biologist Division of Wildlife Conservation

Table 1. Definitions of goshawk nesting, nest use and occupancy in Southeast Alaska.

Term	Definition/Comment
nest site	Nest, nest tree, and forested area surrounding the nest that includes prey handling areas, perches and roosts, and may contain ≥ 1 alternate nest. Nest sites in SE Alaska are approximately 5–15 ha.
nest stand	Nest site and the associated contiguous forested area where stand structure is relatively homogeneous. Nest stands in SE Alaska may vary in size from 5 to > 50 ha and include ≥ 1 goshawk nest site.
nesting area	Landscape area up to 804 ha (= 1987 ac; = 3.11 mi^2) that includes all nest sites and alternate nests used by a pair or individual within its breeding home range. Based on 8 years of radiotelemetry data (see *Interyear movements*). The nesting area includes individual alternate nests or clusters of alternate nests located within a few hundred meters of each other (e.g., Crocker-Bedford 1990, 1995), as well as other individual or clustered alternate nests at nest stands that may be separated by 1–3 km but are located within the normal movement patterns and breeding home range of a pair.
breeding home range	Landscape area encompassing all radiotelemetry relocations documented for an individual or pair during the breeding season, March 1 to August 15.
annual home range	Landscape area that includes all radiotelemetry relocations documented for an individual or pair during a year.
territory	Term not used in our analysis as it traditionally defines a use area based on intraspecific defensive behavior, which is largely unobservable for goshawks. In other N.A. goshawk studies (e.g., Woodbridge and Detrich 1994, Reynolds, et al. 1994) the term territory has been used to describe the landscape area encompassing all known nests used by a pair or individual. This use is synonymous with our definition of nesting area.
active nest	Any of the following: presence of defensive adult(s) at a nest, fresh greenery or other evidence of recent nest construction, eggs present in nest, young present in nest, pre-dispersal fledglings located in the vicinity of a nest that was determined active that year by the presence of fresh whitewash, goshawk feathers, prey remains, or pellets.
active nesting area	Any of the criteria for an active nest plus, when the physical nest could not be located – when only fledglings could be observed and other evidence such as prey remains or aggressive adults indicated that the active nest was nearby.
inactive	None of the active nest and active nesting area evidence could be found.
nesting area occupied	Any of the following: adult goshawk(s) present, recent prey remains, molted goshawk feathers located, or ≥ 1 breeding or nonbreeding radiotagged adult goshawk present in the nesting area during the breeding season.
nesting area unoccupied	Unable to determine with high degree of confidence between unoccupied or inactive in a given year. This is due to variability in the ability to detect goshawks in their breeding season home range.

Table 2. Annual status of goshawk nesting areas. Southeast Alaska, 1985–1999.

Nesting Area	80s	90	91	92	93	94	95	96	97	98	99
Ketchikan Area, Tongass N.F.											
Butterball Lake, Heceta Island					G	NAR	O	O	O	O	O
Carroll River, Revilla.Island								G	NA	G	G
Convenient Cove, Hassler Is.				G	G	NA	G	G	O	O	O
Derrumba Ridge, Heceta Is.									NO	O	O
Logjam Creek, P.O.W. Island					NAR	O	O	O	O	O	O
Margaret Lake, Revilla.Is.						NA	G	BR	BR	BR	O
McDonald Lake, Cleveland Pen.											NA
Port Refugio, Suemez Is.(89)	NA	O	O	G	G	B	G	G	O	O	O
Roberts/Cutthroat Crk, P.O.W. Is.							NAR	BR	BR	BR	O
Sarheen Creek, P.O.W. Island			GF	G	G	O	O	O	O	O	O
Sarkar Lake, P.O.W. Island				NAR	O	O	G	O	O	O	O
Timber Knob, Heceta Island								NA	B	C(96)R	BR
Traitors Creek, Revilla.Is.						NAR	BR	O	O	O	O
Twelvemile Arm, P.O.W. Island								NO	O	O	O

A = active nest first located.
B = active alternate nest located.
C = previously known active nest reused; ( ) = year first active.
F = fledgling(s) observed, active nest not located.
G = goshawk(s)/activity observed during breeding season, active nest not located.
N = nesting area documented this year.
O = no goshawk/activity observed, active nest not located.
R = adult(s) radiotagged and/or present.
T = radiotagged goshawk present but did not nest.
X = area not checked.

Table 2. Continued

Nesting Area	80s	90	91	92	93	94	95	96	97	98	99
Stikine Area, Tongass N.F.											
Big John Creek, Kupreanof Is.				NA	BR	O	O	O	O	O	O
Brown Cove, Petersburg Mainland										NA	BR
Camp Carl, Etolin Island									NAR	BR	BR
Cat Creek, Cape Fanshaw						NAR	O	O	X	O	O
Doughnut, Wrangell Island											NAR
Duncan Creek, Kupreanof Is.						NA	O	O	G	O	BR
East Bay of Pillars, Kuiu Island						NAR	BR	X	BR	O	O
Elena Bay, Kuiu Island										NAR	BR
Farragut Bay, Petersburg Mainland											NAR
Irish Lakes, Kupreanof Island								NA	G	O	O
Kadake Bay, Kuiu Island								NAR	O	O	O
Kake, Kupreanof Island (89)	NA	O	X area cut 89		X	X	X	X	X	X	X
Kuakan, Deer Island									NA	B	BR
Madan Bay, Wrangell Mainland										NGF	BR
Mitchell Creek, Kupreanof Is.						NAR	B	O	O	O	O
Mossman Inlet, Etolin Is.(86)	NA	X	X	O	O	X	X	X	X	X	O
Mountain Point, Kupreanof Is.						NAR	O	X	O	O	O
Negro Creek, Port Houghton						NA	G	O	O	O	O
Rowan Creek, Kuiu Island					NAR	RT	G	O	G	O	O
Sanborn Canal, Port Houghton						NA	O	O	X	G	O
Security Bay, Kuiu Island									NAR	O	O
Starfish, Etolin Island			NA	O	O	O	O	X	O	O	BR
Totem Camp, Kupreanof Island						NA	O	X	O	O	O
Tunehean Creek, Kupreanof Island										NA	BR
Upper Totem, Kupreanof Island					NO	O	O	X	G	O	O
West Bay of Pillars, Kuiu Island						NAR	BR	X	O	O	O
Zim Creek, Kupreanof Island											NA

A = active nest first located.
B = active alternate nest located.
C = previously known active nest reused; ( ) = year first active.
F = fledgling(s) observed, active nest not located.
G = goshawk(s)/activity observed during breeding season, active nest not located.
N = nesting area documented this year.
O = no goshawk/activity observed, active nest not located.
R = adult(s) radiotagged and/or present.
T = radiotagged goshawk present but did not nest.
X = area not checked.

Table 2. Continued

Nesting Area	80s	90	91	92	93	94	95	96	97	98	99
Chatham Area, Tongass NF.											
Auke Bay, Juneau Mainland										NAR	O
Blueberry Hill, Douglas Island					NAR	BR	C(93)R	RT	C(94)R	BR	BR
Dewey Lk., Skagway (85)	NA	X	X	X	X	X	X	X	X	X	X
Distin Lake Trail, Admiralty Is.						NA	X	X	B	O	B
Duffield Peninsula, Baranof Is.						NA	C(94)	C(94)	O	X	B
Eagle Creek, Douglas Island					NAR	RT	O	O	O	O	O
Eagle River, Juneau Mainland									NGF	AR	BR
Fish Creek, Douglas Island						NAR	BR	BR	BR	C(96)R	BR
Florence Bay, Chichagof Island								NAR	O	O	O
Green Cove, Admiralty Island								NAR	BR	BR	C(96)R
Lace River, Berners Bay						NAR	RT	O	O	O	X
Mud Bay River, Chichagof Is.					NA	GF	O	X	O	C(93)	O
Nugget Crk., Juneau Mainland					NAR	BR	RT	O	C(93)R	C(94)R	O
Pavlof River, Chichagof Island							NAR	RT	RT	O	O
Point Bridget, Juneau Mainland				NA	BR	O	G	G	G	BR	B
Ready Bullion Crk., Douglas Is.			NA	BR	O	O	O	O	C(91)R	BR	C(92)R
Sitkoh River, Chichagof Island											NA
Tolch Rock, Juneau Mainland											NAR
Turner Lake, Juneau Mainland								NGF	A	G	GF
Whitestone, Chichagof Island							NGFR	AR	O	O	O

A = active nest first located.
B = active alternate nest located.
C = previously known active nest reused; ( ) = year first active.
F = fledgling(s) observed, active nest not located.
G = goshawk(s)/activity observed during breeding season, active nest not located.
N = nesting area documented this year.
O = no goshawk/activity observed, active nest not located.
R = adult(s) radiotagged and/or present.
T = radiotagged goshawk present but did not nest.
X = area not checked.

Table 3. Breeding (nesting) season, nonbreeding season, and year-round use areas for adult female northern goshawks, Southeast Alaska, 1992–1999. One hundred percent and ninety-five percent minimum convex polygons (MCP) from radiotelemetry locations.

Adult Females		Locations	100% MCP (ha)	95% MCP (ha)
Breeding season	Mean	31	4,549	4,153
	SD	18	2,465	2,423
(Mar. 1 to Aug. 15)	Median	27	4,304	4,223
	First quartile		2,648	2,108
n = 16 birds [a, b]	Third quartile		5,767	5,455
	Minimum	11	975	871
	Maximum	67	9,986	8,968
Nonbreeding season	Mean	26	33,839	32,961
	SD	14	42,134	42,950
(Aug. 16 to Feb. 29)	Median	24	14,718	12,602
	First quartile		5,630	4,144
n = 18 birds [a]	Third quartile		50,701	59,023
	Minimum	10	2,146	2,146
	Maximum	62	147,113	146,926
Year-round	Mean	43	54,218	49,465
	SD	29	61,756	60,360
(all months)	Median	35	16,619	11,688
	First quartile		9,852	9,048
n = 27 birds [a]	Third quartile		93,886	90,209
	Minimum	10	3,995	3,035
	Maximum	107	180,036	180,036

[a] Includes birds with ≥ 10 locations.

[b] Does not include 1 adult female that moved >44 km from her nesting area on August 3 and returned on August 7, resulting in a 100% MCP breeding season use area of 29,600 ha.

Table 4. Breeding (nesting) season, nonbreeding season, and year-round use areas for adult male goshawks, Southeast Alaska 1992–2000. One hundred percent and ninety-five percent minimum convex polygons (MCP) from radiotelemetry locations.

Adult Males		Locations	100% MCP (ha)	95% MCP (ha)
Breeding season	Mean	27	5,910	4,785
	SD	17	4,776	3,332
(Mar. 1 to Aug. 15)	Median	24	4,258	3,924
	First quartile		3,257	2,886
n = 21 birds [a]	Third quartile		6,579	5,518
	Minimum	10	1,229	1,229
	Maximum	73	19,469	15,361
Nonbreeding season	Mean	27	19,454	16,503
	SD	11	16,464	15,601
(Aug. 16 to Feb. 29)	Median	25	13,358	13,024
	First quartile		7,706	5,946
n = 14 birds [a, b]	Third quartile		24,257	19,684
	Minimum	17	5,996	3,702
	Maximum	57	63,738	63,513
Year-round	Mean	44	15,871	12,508
	SD	28	15,665	14,150
(all months)	Median	43	11,243	6,279
	First quartile		6,320	4,530
n = 22 birds [a, b]	Third quartile		20,261	14,441
	Minimum	13	1,949	1,949
	Maximum	117	67,444	63,908

[a] Includes birds with ≥ 10 locations.

[b] Does not include 1 adult male that dispersed >80 km from its nesting area during the nonbreeding season and whose nonbreeding season and year-round 100% MCPs use areas were 231,509 ha.

Appendix. Selected abstracts of papers presented at professional meetings and of thesis by Stephen B. Lewis on northern goshawk diet in Southeast Alaska.

Abstract of paper presented at annual meeting of the Raptor Research Foundation, Ogden, Utah, 1998.

Northern Goshawks (*Accipiter gentilis*) and Forest Management on the Tongass National Forest – Alaska

K. Titus, Alaska Department of Fish and Game, Division of Wildlife Conservation, Douglas, AK 99824 USA, G.C. Iverson, USDA Forest Service – Alaska Region, Juneau, AK 99802 USA, R.E. Lowell, ADF&G, Douglas, AK USA and C.J. Flatten, ADF&G, Ketchikan, AK USA

The Tongass National Forest (16.9 million acres; 68,000 km^2) contains some of the largest remaining tracts of old-growth temperate coastal rainforest in the world. ADF&G and the US Forest Service began cooperative studies of the Northern Goshawk in the early 1990's. By 1992 interim goshawk habitat management guidelines were issued for the Tongass National Forest and there was an attempt to develop a conservation strategy for maintaining habitats so that old-growth associated wildlife remained viable and well distributed across the Tongass. The 1979 forest plan and interim management guidelines for goshawks were identified as being inadequate to conserve goshawks across the Tongass. In 1994 the Fish and Wildlife Service was petitioned list the Queen Charlotte Goshawk as endangered under the Endangered Species Act. An interagency goshawk conservation assessment was prepared in 1996 to provide the Forest Service with the best available science-based information for decision-making. Study results indicated that goshawks had large use areas (approximate home ranges; 69 km^2 adult ♂ nesting season, n = 16) and that goshawks were selecting for old growth forest. Interpretation of results suggested that the probability of persistence of goshawks has declined over the past 50 years based on past and present forest management practices. The authors felt that a reserve system was an important but incomplete component of a long-term management strategy to maintain goshawks across the forest. Risk assessment panels were held during the forest plan revision in 1996 and 1997 to evaluate the likelihood that goshawk populations would remain viable and well distributed across the forest under alternative management scenarios. Goshawk panel experts suggested that the reserve system should be combined with other approaches including extended timber rotations, management of the intervening forest matrix where timber harvest would occur, and extended riparian and beach habitat protection buffers. The final Tongass forest plan contains elements resulting from the science-based goshawk information base.

Abstract of paper presented at annual meeting of the Raptor Research Foundation, LaPaz, Mexico, 1999

Monitoring, Territory Reoccupancy, and Interyear Movements of Adult Northern Goshawks (*Accipiter gentilis*) on the Tongass National Forest, Alaska: lessons from a long-term Radiotelemetry Study. KIMBERLY TITUS, Richard E. Lowell**,** Alaska Department of Fish and Game, Box 240020, Douglas, Alaska 99824 USA, and Craig J. Flatten, Alaska Department of Fish and Game, 2030 Sea Level Drive, Ketchikan, Alaska 99901 USA.

The Tongass National Forest contains some of the largest remaining tracts of old-growth temperate rainforest in the world. Management of these forestlands includes efforts to conserve and maintain habitats for a variety of wildlife, including goshawks. ADF&G and the US Forest Service began

cooperative studies in 1992 to understand the ecology of goshawks in an old-growth temperate forest ecosystem. As part of these efforts we have been monitoring goshawk nest sites and nest stands with the aid of radiotelemetry. Since 1992 we have captured 135 goshawks, and a total of 51 adults have been fitted with radio tags. We use radiotelemetry to track the interyear movements of adult goshawks. Between 1992 and 1998, 9 adult female goshawks moved to different nesting territories a total of 11 times and nested with different mates. These females move a mean of 34 km (range = 3.2–152 km). Of 26 adult male goshawks radiotagged, none have moved to a new nesting territory. Results from our radiotelemetry data suggest that annual monitoring of nest stands and checking old nest sites for occupancy by goshawks can provide misleading information. Depending on how the monitoring is actually designed, one could conclude that a raptor nesting population is declining simply because of interyear movements by nesting adults to sites that are unknown. This is especially true for studies in dense forests where large, complete censuses of all nesting pairs are impossible. Our radiotelemetry results also indicate that some home ranges are occupied by nonnesting goshawks, and that some pairs move 2–3 km to different nests between years, while maintaining the same home range as previous years. Hence it would be improper to suggest that these territories are "unoccupied," but this would be an often used interpretation in many raptor-monitoring projects.

Abstract of paper presented at annual meeting of American Ornithologists Union meeting – Seattle, 2001.

Color and Size of the Northern Goshawk in Southeast Alaska. CRAIG FLATTEN*, Alaska Dept. of Fish and Game, Ketchikan, AK; KIM TITUS, Alaska Dept. of Fish and Game, Douglas, AK; RICHARD LOWELL, Alaska Dept. of Fish and Game, Petersburg, AK.

The taxonomy of Northern Goshawk (*Accipiter gentilis*) subspecies in N.A. is currently a topic of interest and debate. Resource managers are required to maintain well-distributed, viable goshawk populations and to protect distinct population segments that may be threatened or endangered. The AOU recognizes two Northern Goshawk subspecies in N.A.: *A.g. atricapillus and A.g. laingi.* Some question the validity of Northern Goshawk subspecies that are based primarily on subtle color and size distinctions. The *laingi* subspecies has been described as a smaller and darker race inhabiting the coastal temperate rainforests of British Columbia and Southeast Alaska. Information on plumage coloration and body size was collected from 68 adult and 70 juvenile goshawks captured at nest sites in Southeast Alaska between 1992 and 2000. Phenotypes ranged from dark forms identified as *laingi* to lighter forms identified as *atricapillus*. Mean wing chords were smaller than those reported for Northern Goshawks from other regions of Alaska, but larger than those reported for *laingi* specimens from coastal British Columbia. Slight clinal variation in size within Southeast Alaska was detected in some age-sex classes with smaller birds occurring in the south. Results generally support the original description of *laingi*, noting the occurrence of some clinal variation and probable intergradation of subspecies within Southeast Alaska.

Abstract of paper presented at annual meeting of American Ornithologists Union meeting – Seattle, 2001.

Breeding dispersal of adult Northern Goshawks in Southeast Alaska: implications for conservation.
KIMBERLY TITUS*, Alaska Dept. Fish and Game, Juneau, AK, CRAIG FLATTEN, ADF&G, Ketchikan, AK; and RICHARD LOWELL, Petersburg, AK.

Northern Goshawks nest in the old-growth temperate rainforests of Southeast Alaska and are a conservation concern for forest management activities. We evaluated breeding dispersal (movement from one nest to another in consecutive years), nesting status, and fate of adult goshawks during 1992–99 by tracking them with radiotelemetry. We defined a nest area as a 3.2 km diameter area because this was the maximum distance a pair moved in consecutive years while maintaining the same home range. Multiyear movements were determined for 23 females and 21 males at 27 nest areas. Breeding dispersal was observed only for adult females and no adult male moved to a new home range or nest area. For 13 nests located by tracking adult females to a different nest area in consecutive years, the median distance moved was 18.5 km; maximum distance moved was152 km. In 55% of our consecutive year outcomes the goshawk pair nested in the same nest area as the previous year. Overall, 31% of adult females dispersed to a new home range in consecutive years and either nested with a different mate or did not nest. These complex dispersal patterns by adult female goshawks present challenges to those charged with monitoring goshawks and/or their nests.

Citation and abstract of thesis by Stephen Lewis on northern goshawk diet in Southeast Alaska.

Lewis, Stephen B. 2001. Breeding season diet of northern goshawks in Southeast Alaska with a comparison of techniques used to examine raptor diet. Thesis. Boise State University. Boise, Idaho. 125pp.

Chapter 1
A video surveillance system for monitoring raptor nests in a temperate rainforest environment.

Abstract: I used a video surveillance system to monitor northern goshawk (*Accipiter gentilis*) nests in the coastal temperate rainforest of Southeast Alaska to gather data on their diet. I maintained five systems during the goshawk nesting seasons in 1998 and 1999, installing the cameras an average of 10 days after hatching. At these 10 nests, cameras were maintained for an average of 33 days, recording 5834 hours of nest-time. I captured an average of 69.3% of the daylight hours available from hatching to the day nests were no longer used by juvenile northern goshawks. Technical difficulties associated with maintaining video cameras in this rainforest environment included electronic malfunctions, recurrent battery failure, and problems with the recorded image. However, these video surveillance systems effectively monitored northern goshawk nests and could be adapted for most rainforest raptors that nest on open platforms. I recommend testing the systems under field conditions in which they are to be used prior to deployment.

Chapter 2

Comparison of three techniques for assessing raptor diet during the breeding season.

Abstract: Video recording of prey deliveries at nests is a new technique for collecting data on diet and food habits that has not been compared with results from collections of prey remains and pellet. As part of a study of the breeding season diet of northern goshawks (*Accipiter gentilis*) in Southeast Alaska, I compared data from these three techniques to determine the relative merits of the different methods for assessing diet. I monitored 5 nests during the northern goshawk breeding seasons of 1998 and 1999 and identified 1,541 prey from deliveries, 209 prey from remains, and 209 prey from pellets. The proportions of birds and mammals varied among techniques, as did the relative proportions of prey groups and age groups. Analysis of prey deliveries gave the narrowest diet breadth of the three techniques. Prey remains and pellets gave the least similar diet descriptions. Over two-day intervals during which data was collected using all three techniques, prey deliveries gave more individual prey and prey categories than the other two techniques. I found that prey was not directly tracked through all three techniques. Analysis of prey deliveries collected by remote videography provided the most complete description of diet and I recommend that studies attempting to describe diet use this method or some other direct technique.

Continued on next page

Chapter 3

Breeding season diet of northern goshawks in Southeast Alaska.

Abstract: I provided the first systematic description and quantification of the nesting season diet of northern goshawks (*Accipiter gentilis*) in Southeast Alaska and examined how their diet varied within this island archipelago. I collected data on the diet of goshawks using three techniques. I used remote videography to record prey deliveries at nests in two spatially distinct locations of Southeast Alaska to describe the diet in detail and examine spatial variation in the diet. I used prey remains and pellets collected at nests throughout Southeast Alaska to describe the diet of the goshawk over a broader spatial scale. Goshawks delivered more birds than mammals overall of Southeast Alaska but delivered more birds in the Prince of Wales Island area than in other parts of Southeast Alaska. In northern Southeast Alaska, blue grouse (*Dendragapus obscurus*), red squirrels (*Tamiascurius hudsonicus*), Steller's jays (*Cyanocitta stelleri*), varied thrushes (*Ixoreus naevius*), northwestern crows (*Corvus caurina*) and unknown passerine birds were the prey that contributed the most to the diet. In southern Southeast Alaska, spruce grouse (*Falcipennis canadensis*), Steller's jay, ptarmigan species (*Lagopus* spp.), varied thrushes, and unknown passerine birds were the commonly eaten prey. Diet niche was narrower in the north than in the south and nests in these areas, on average, showed little overlap. The relative proportion of grouse and thrushes in the diet appeared to vary as the nesting season progressed, as did the relative proportion of different aged prey. Data from prey remains and pellets collected over all of Southeast Alaska provided similar results as that from remote videography. In Southeast Alaska, goshawks ate similar types of prey as seen in other locations. My data support the supposition that goshawks are generalist predators and show a certain amount of adaptability in their tolerance to varying prey bases. However, there appears to be a limit to this adaptability, which was apparent on Prince of Wales Island. In this area, an extremely restricted prey base in combination with extensive landscape alteration due to timber harvest appears to have affected goshawks' ability to successfully reproduce. Goshawks in Southeast Alaska rely on a few important prey species that can be affected by timber harvesting activities. Therefore, management should focus on conserving forests that structurally and functionally mimic those that historically covered this region.
